[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention relates to the surface treatment method of the high energy product rare earth permanent magnet used for the magnetic head driving device of an AC servo motor, a linear motor, and the hard disk for data recording.
[0002]
[Description of the Prior Art]
Although the permanent magnet material which consists of the rare earth element which uses Nd as the main ingredients, a transition element which uses iron as the main ingredients, and B is used abundantly as strongest magnet with the highest energy product of now at the motor for industrial use etc., Since the rare earth element which are iron and activity metal as an ingredient is included, with the moisture in the air, rust is produced and magnetic properties fall easily. For this reason, rustproof films, such as plating and paint, are used for the surface, forming.
In it, how to form a protective film by the plating method is shown in drawing 4. Drawing 4 is a cross section showing the conventional rare earth permanent magnet. nickel strike plating layer 3 by electrolysis is formed in the surface of the rare earth permanent magnet 1, and electric nickel plating layer 4 is formed on it (for example, JP,05-082322,A). In this case, as pretreatment of plating, by the surface treatment method of the wet type using solution, adjustment of a magnet base is performed and the plating coat is formed after that.
[0003]
[Problem(s) to be Solved by the Invention]
However, in the above-mentioned conventional method, the rare earth permanent magnet surface at the time of plating pretreatment changes, as shown in drawing 5. $Nd_1Fe_4B_4$ phase and 7 are Nd rich phases Nd_2Fe_{14} B phase whose 5 is a main phase in a magnet material, and 6. That is, the activity electrochemically Nd rich phase 7 which exists in the boundary of the particles of Nd_2Fe_{14} B phase 5 dissolves into a treating solution preferentially. For this reason, there was a problem that the adhesion between the plating coat which the fixing force of the grains of a main phase declines and is formed after that, and a magnet base became low. Therefore, in the motor which pasted up the magnet after plating on the motor core, the fault that a magnet exfoliated in the interface of a plating coat and a magnet base might be produced according to the centrifugal force at the time of the expansion contraction and the high velocity revolution at the time of the heat cure of adhesives.
Then, the purpose of this invention is to provide the surface treatment method of magnet materials for adhesion with a magnet base to form a good plating coat.
[0004]
[Means for Solving the Problem]
In order to solve the above-mentioned problem, in this invention, it quenches, after fusing the surface of a permanent magnet material which consists of a rare earth element which uses Nd as the main ingredients, a transition element which uses iron as the main ingredients, and B, and a plating layer for protecting a magnet base is formed on this

melting layer. Since a chemical-resistant good amorphous layer will generate on the magnet surface and a magnet base will be protected by this amorphous layer if melting quenching only of the surface of a rare earth permanent magnet is carried out, fixing force of particles of a main phase does not decline in the case of plating pretreatment. Since a plating coat is formed on an amorphous layer, it does not produce a fall of adhesion power of a plating coat, either.
Although it is considered as a method of carrying out melting quenching of the magnetic surface and there are various methods, a method of using a laser beam is most suitable as a method of fusing only a magnet surface layer, without raising temperature of a magnet body, since energy can be concentrated on minute sections while being able to process in the atmosphere.
[0005]
[Embodiment of the Invention]
The embodiment of this invention is described based on figures.
The cross section of the rare earth permanent magnet which produced drawing 1 with the surface treatment method of this invention, and drawing 2 show the enlarged section mimetic diagram of a surface treatment part. 2 is an amorphous layer and other numerals are the same as the former.
In order to fuse the surface of the rare earth permanent magnet 1 which consists of the rare earth element, iron, and B which use Nd as the main ingredients, the laser heating device shown in drawing 3 was used. The laser heating device of drawing 3 comprises the laser light source 9, the optical system 10 which converges laser on a narrow beam and X-Y stage 12 which moves a rare earth permanent magnet to the 2-way of XY, and its controller 13.
After fusing the surface of a rare earth permanent magnet by using the YAG laser of the maximum output 100W for the laser light source 9, and changing the movement speed of X-Y stage 12, a laser output, and the pulse number per second, it adjusted so that it might quench and an amorphous layer about 15 micrometers thick could be formed.
It quenched and the amorphous layer was formed, after fusing all the magnetic surface of the 6th page. Then, alkaline degreasing, electrolytic degreasing, and pickling treatment were performed, it was immersed into the plating liquid containing chloridation nickel and chloride, and strike nickel plating was performed. Electric nickel plating was performed to 20 micrometers of thickness after rinsing in sulfuric acid nickel, chloridation nickel, and the plating liquid containing way acid.
The sample which performed surface etching by wet process, alkaline degreasing, and activation, and performed strike nickel plating and electric nickel plating on the same conditions as an example like the conventional nickel plating rare earth permanent magnet as a comparative example was also produced (drawing 4).
The epoxy adhesive was used for steel blocks and both nickel plating rare earth permanent magnet of this example and a comparative example was pasted up on them, respectively. Shear peel strength was investigated for adhesives after heat cure. The crack which reaches to a magnet base was put into nickel plating film in phi10mm shape, and the rod made from phi10mm carbon steel was stuck on this with epoxy adhesive. After carrying out heat cure of the adhesives, the magnet was pulled and it fixed to one side of a testing machine, and it has already fixed to one of the two, the rod was pulled apart, and the adhesion strength of the plating coat was investigated.

The result is shown in Table 1. Table 1 is the average value which measured the shear peel strength and adhesion strength of the plating film of nickel plating rare earth permanent magnet.
[0006]
[Table 1]

測定品	せん断剥離強度（kgf／cm^2）	めっき密着強度（kgf／cm^2）
実施例	２８５	５８０
比較例	１０８	３７２

[0007]
All exfoliations of the rare earth permanent magnet of this example were produced the interface of adhesives and nickel plating coat, and inside the adhesives layer, and all exfoliations were produced in the magnetic surface and the interface of the strike nickel plating coat about the comparative example.
The example of this invention has the good adhesion between a magnet base and nickel plating, and it was able to make it stronger [than Table 1] than the mechanical strength of the adhesives themselves. For this reason, adhesives were used and attached to the rotor of a motor, and even if it rotated at high speed, it did not exfoliate from the interface of a magnet and a plating coat.
Although laser was used in this example as a method of carrying out melting quenching of the magnet surface, and forming an amorphous layer, a work is put in a vacuum, and the same effect is acquired, even if an electron beam is applied and it fuses the surface. In addition, if it is the methods of giving the energy which fuses only the surface of a rare earth permanent magnet, such as the method of fusing the surface using the spark by discharge, the effect of raising the adhesion of the magnet surface and a plating film will be acquired like the example of this invention.
Although electric nickel plating coat was formed in the magnet surface in this example, A plating coat is not limited to electrolysis plating of nickel, it is metal which can form a metallic film with electrolysis plating or nonelectrolytic plating from solution, such as Cu, Ag and Au, and Cr, and if a resistance to environment is good, the protective effect of the same adhesion as nickel plating and a magnet base will be acquired.
[0008]
[Effect of the Invention]
Since the good plating protective film of a magnet base and adhesion can be formed according to the surface treatment method of the rare earth permanent magnet according to claim 1 as stated above, The fault of exfoliating in a magnetic base and the interface of plating according to the centrifugal force at the time of the expansion contraction at the time of the heat cure after adhesion to a motor core or the high velocity revolution of a motor is not produced. For this reason, a reliable AC servo motor and linear motor can be manufactured. Since melting rapid cooling treatment on the surface of a magnet for forming the good plating film of adhesion can be performed in the atmosphere according

to the surface treatment method of the rare earth permanent magnet according to claim 2, a rare earth permanent magnet with a plating coat can be manufactured cheaply.

[Brief Description of the Drawings]

[Drawing 1]The mimetic diagram of the rare earth permanent magnet section produced with the surface treatment method of this invention.

[Drawing 2]The enlarged section mimetic diagram of the surface treatment part in drawing 1.

[Drawing 3]The lineblock diagram of the laser heating device used for the surface treatment of this invention.

[Drawing 4]The mimetic diagram of the rare earth permanent magnet section produced with the conventional surface treatment method.

[Drawing 5]The explanatory view explaining a mechanism with poor adhesion of the conventional rare earth permanent magnet.

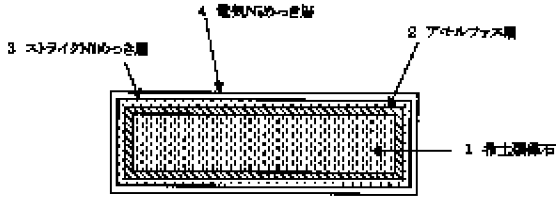
[Description of Notations]

1 Rare earth permanent magnet
2 Amorphous layer
3 Strike nickel plating layer
4 Electric nickel plating layer
5 Nd_2Fe_{14} B phase
6 $Nd_1Fe_4B_4$ phase
7 Nd rich phase
8 The power supply for laser
9 Laser light source
10 Optical system
11 Laser beam
12 X-Y stage
13 X-Y stage controller

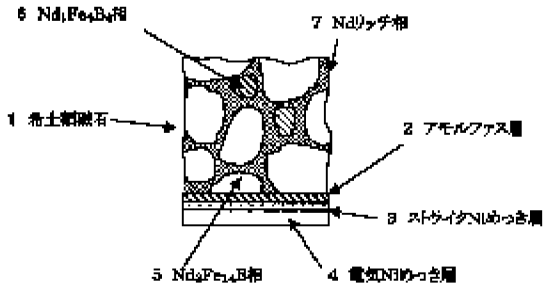
EFFECT OF THE INVENTION

[Effect of the Invention]

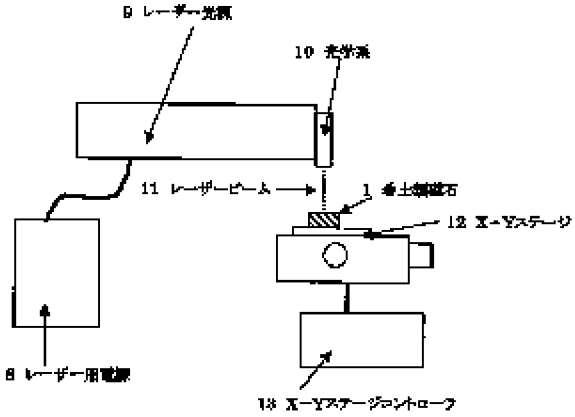
Since the good plating protective film of a magnet base and adhesion can be formed according to the surface treatment method of the rare earth permanent magnet according to claim 1 as stated above, The fault of exfoliating in a magnetic base and the interface of plating according to the centrifugal force at the time of the expansion contraction at the time of the heat cure after adhesion to a motor core or the high velocity revolution of a motor is not produced. For this reason, a reliable AC servo motor and linear motor can be manufactured. Since melting rapid cooling treatment on the surface of a magnet for forming the good plating film of adhesion can be performed in the atmosphere according to the surface treatment method of the rare earth permanent magnet according to claim 2, a rare earth permanent magnet with a plating coat can be manufactured cheaply.



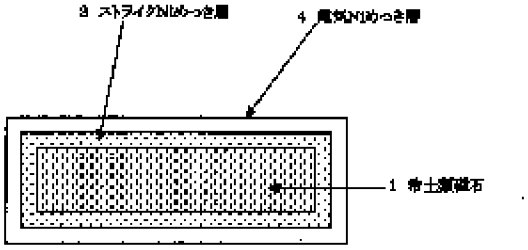
Drawing 1



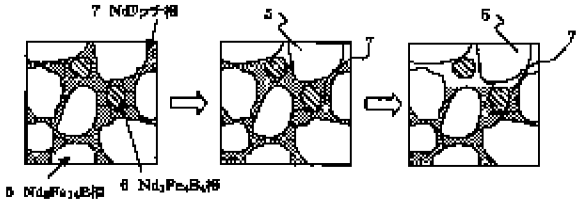
Drawing 2



Drawing 3



Drawing 4



Drawing 5